PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
146322.3 SB		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IL 03/00606	24.07.2003	24.12.2002
International Patent Classification (IPC) or both national classification and IPC		
H02M3/335		
Applicant		
LIGHTECH ELECTRONIC INDUSTRIES LTD.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
21.07.2004	29.03.2005
Name and mailing address of the international preliminary examining authority:	Authorized Officer
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/IL 03/00606

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1, 2, 5-10	as originally filed
3, 3a, 4	received on 21.07.2004 with letter of 21.07.2004

Claims, Numbers

1-18	received on 21.07.2004 with letter of 21.07.2004

Drawings, Sheets

1/4-4/4	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-18
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-18
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-18
	No:	Claims	

2. Citations and explanations

see separate sheet

Re Item V

Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: DE-A-4227183
D2: US-B1-6246596

Document D1 (see figure and column 2 lines 14-40), which is considered to represent the most relevant state of the art, discloses a startup circuit (2) for a power supply(1) comprising:
- an input (U_E) for connecting a source of high voltage thereto,
- an output rail (again U_E) for feeding rectified voltage to the power supply (U_E is clearly suitable for such purpose, also keeping in mind that a rectified voltage can be at the same time a high voltage)
- a first energy storage device (10) coupled to the output rail (UE) for storing energy when voltage is first applied to the input
- a second energy storage device (15) coupled to an output (14) of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and
- a switching circuit (14) coupled to the first energy storage device (10) and to the second energy storage device (15) and being responsive to the first energy storage device (10) having sufficient energy (condition detected via 11 and 12) for transferring said energy to the second energy storage device (15).

Subject matter of claim 1 differs therefor from such known startup circuit in that:
a) the power supply is a universal or variable power supply that is adapted to operate over a range of power supply voltages fed to the input
b) a starting resistor is coupled between the output rail and the first energy storage device for sourcing current to the first energy storage device and
c) the switching circuit is responsive to the first energy storage device having sufficient energy for disconnecting the starting resistor from the output rail.

Claim 1 satisfies, therefore, the requirements of Article 33(2) PCT about novelty.

The problem to be solved by the invention of claim 1 with respect to prior art D1 may therefore be regarded as: decreasing the losses associated with the startup capacitor charging section (9,10) of D1, once the power supply reaches steady state.

Although D1 clearly states (column 1 lines 26-28) that the startup circuit should in principle be disabled after the power supply reaches steady state, this is not done in the embodiment shown in the figure or in the remaining of the description because, as explained in column 2 lines 28-32, the charging circuit of the first capacitor is highly resistive and little dissipative, so that the possibility of immediately restarting the charging of capacitor 10 in case of operational problem (such as failed start-up attempt of the control circuit 5, see column 2 lines 27-40) is preferred to the possibility of completely eliminating the charge current losses after startup.

Thus it can be considered that D1 teaches away from the proposed solution, and it is likely that the skilled person, if not prepared to tolerate capacitor charging currents after startup, would abandon the start-up circuit of D1.

Claim 1 can therefore be considered to involve an inventive activity and it satisfies the requirements of Article 33(3) PCT.

Claims 2-17, which depend on claim 1, are consequently also new and inventive.

Independent method claim 18 is also new and inventive for the same reasons, mutatis mutandis, already given for claim 1.

Subject matter of claims 1-18 finds an industrial applicability in the field of power supplies for low voltage equipment.

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transformer 15 after startup. The second transistor 21 feeds the resulting voltage to the control circuit, which is driven thereby, and inverts the first transistor from conduction to cutoff thereby effectively disconnecting the starting resistor 17.

Thus, the power supply unit saves electricity during standby by separating starting resistance after a startup (of a switching circuit), and driving the control circuit of a main switching element by only power generated in an output transformer.

It will be seen from Fig. 2 that an electrolytic capacitor 23 is connected across the input immediately after the bridge rectifier 13. The purpose of the electrolytic capacitor 23 is to store energy from the mains and serve as an auxiliary supply in the event of a momentary outage or fluctuations in the main voltage. In order to serve this function, the capacitor 23 must have a high capacitance and indeed this is the reason that an electrolytic capacitor is employed. However, the connection of a high capacitance at the input of the circuit militates against the power supply having near unity power factor. This may not matter too much when the power supply is to be used with computers and the like. However, there are many applications where near unity power factor is required and, in such cases, the circuit shown in JP 2001275347 is unsuitable.

In order to achieve near unity power factor, a high capacitance of the order of 200 nF is usually disposed near the output of the power supply. This increases the time that it takes for steady state to be reached and this in turn increases the time before the startup circuit must be disabled. In JP 2001275347 the time taken between the first switch 18 opening and the second switch 14 closing is too fast to allow complete charging of such capacitance. This also indicates that the circuit disclosed in JP 2001275347 is unsuited for use with power supplies having near unity power factor.

DE 42 27 183 discloses an electronic switching device for the delivery of a start-up supply voltage in a switched-mode (or synchronized) power supply. A switching device supplies the start-up supply voltage to an electronic control circuit whose output is connected to an electronically controlled pulse switch. After the

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controlled pulse switch starts pulsing, the electronically controlled circuit is supplied by an operating voltage circuit. A first capacitor charges when voltage is first applied; and a second capacitor is coupled to an output of the power supply for charging when a voltage appears at the output of the power supply. The first capacitor is charged at high impedance by the input voltage. Under regular operating conditions, and after reaching a threshold voltage, the charge of the second capacitor becomes available to the post-connected electronic control circuit at very low impedance.

US 6,246,596 (Yamazaki) published June 12, 2001 and entitled "*Switching power supply*" discloses a switching power supply includes a power factor improvement circuit controlled by two control ICs fed by respective capacitors, and at least one start-up circuit for controlling start-up of the two control ICs.

It would therefore be desirable to provide a startup circuit for a power supply, particularly a universal power supply having near unity power factor, wherein the starting resistor is disconnected after the power supply has reached steady state, thereby preventing energy loss and improving efficiency.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a startup circuit for a power supply having near unity power factor, having a starting resistor that is disconnected after the power supply has reached steady state, thereby preventing energy loss and improving efficiency.

To this end there is provided in accordance with the invention a startup circuit for a power supply, said startup circuit comprising:

an input for connecting a source of high voltage thereto,

an output rail for feeding rectified voltage to the power supply,

a first energy storage device coupled to the output rail for storing energy when voltage is first applied to the input,

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a second energy storage device coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and

a switching circuit coupled to the first energy storage device and to the second energy storage device and being responsive to the first energy storage device having sufficient energy for transferring said energy to the second energy storage device and disconnecting the first energy storage device from the output rail;

characterized in that:

the power supply is a universal or variable power supply that is adapted to operate over a range of power supply voltages fed to said input,

a starting resistor is coupled between the output rail and the first energy storage device for sourcing current to the first energy storage device, and

the switching circuit is responsive to the first energy storage device having sufficient energy for disconnecting the starting resistor from the output rail.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Fig. 1 is a partial circuit diagram showing schematically a conventional startup circuit in a typical low voltage power supply;

Fig. 2 is a partial circuit diagram showing schematically a prior art power supply;

Fig. 3 is a block diagram showing functionally an improved startup circuit according to the invention; and

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CLAIMS:

1. Startup circuit (30) for a power supply (44), said startup circuit comprising:

an input (31) for connecting a source of high voltage thereto,

an output rail (33) for feeding rectified voltage to the power supply,

a first energy storage device (35) coupled to the output rail for storing energy when voltage is first applied to the input,

a second energy storage device (37) coupled to an output of the power supply for storing energy when a voltage appearing at the output of the power supply reaches substantially steady state, and

a switching circuit (36, 50) coupled to the first energy storage device and to the second energy storage device and being responsive to the first energy storage device having sufficient energy for transferring said energy to the second energy storage device and disconnecting the first energy storage device from the output rail;

characterized in that:

the power supply (44) is a universal or variable power supply that is adapted to operate over a range of power supply voltages fed to said input (31),

a starting resistor (R5) is coupled between the output rail (33) and the first energy storage device (35) for sourcing current to the first energy storage device (35), and

the switching circuit is responsive to the first energy storage device having sufficient energy for disconnecting the starting resistor (R5) from the output rail (33).

2. The startup circuit according to Claim 1, being part of a power supply for an LED lighting system.

~~2.~~3. The startup circuit according to Claim 1 or 2, wherein the first energy storage device is a first capacitor (35).

~~2.~~4. The startup circuit according to any one of Claims 1 ~~or to~~ 3, wherein the second energy storage device is a second capacitor (37).

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~~2.5.~~ The startup circuit according to Claim 3 or 4, including:

a current source (34) connected to the input for charging the first capacitor, and

a first comparator (38) having a first input (39) coupled to an output of the first capacitor (35) and having a second input (40) connected to a first reference voltage (VR1) for generating a first switching signal when the output of the first capacitor exceeds the first reference voltage;

a second comparator (41) having a first input (42) coupled to an output of the second capacitor (37) and having a second input (43) connected to a second reference voltage (VR2) for generating a second switching signal when the output of the second capacitor exceeds the second reference voltage;

said switching circuit (36, 50) being responsive to the first switching signal for changing from an initially open circuit wherein the first capacitor is isolated from the second capacitor to a closed circuit whereby the first capacitor is connected in parallel with the second capacitor; and being responsive to the second switching signal for disabling charge flow to the first capacitor.

~~5.6.~~ The startup circuit according to Claim 5, wherein the switching circuit (36, 50) includes:

a first switch (50) coupled to the current source and having an initial state wherein the current source is coupled to the first capacitor and having a second state wherein the current source is decoupled from the first capacitor, and

a second normally open switch (36) coupled between respective outputs of the first and second capacitors.

~~6.7.~~ The startup circuit according to Claim 6, wherein the first and second switches include semiconductor devices (Q1, Q4).

~~6.8.~~ The startup circuit according to Claim 7, wherein the first and second switches are bipolar junction transistors (Q1, Q4).

~~6.9.~~ The startup circuit according to any one of Claims 5 to 8, wherein the first comparator (38) includes a zener diode (D3).

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6.10. The startup circuit according to any one of Claims 5 to 9, wherein the second comparator (41) includes a zener diode (D1).

6.11. The startup circuit according to any one of Claims 5 to 10, wherein the current source (34) includes a transistor (Q2) for feeding current through a resistor (R5).

6.12. The startup circuit according to any one of Claims 5 to 11, wherein the switching circuit (36) includes a first switch (50) comprising resistors (R1, R2, R3, R4) in combination with a transistor (Q1) for controlling the current source (34).

6.13. The startup circuit according to any one of Claims 5 to 12, wherein the switching circuit includes a second switch (36) comprising resistors (R8, R9) in combination with a transistor (Q4).

6.14. A universal or variable power supply including the startup circuit according to any one of Claims 1 to 13.

6.15. The power supply according to Claim 14, being an integral unit.

6.16. The power supply according to Claim 14 or 15, being part of an LED lighting system.

6.17. The power supply according to any one of Claims 14 to 16, including a power factor correction circuit.

18. A method for achieving substantially constant losses in a universal or variable power supply having an output rail (33) that feeds current to a capacitor (35) via a resistor (R5) and is coupled to a lamp control circuit that is fed by a backup power supply in steady state, the method comprising:

decoupling the resistor from the output rail when steady state is achieved so as to eliminate losses through the resistor.